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COMPLETE SPECIFICATION

Improvements in or relating to Heat Exchange Apparatus

We, CHARLES ZEUTHEN, RICHARD ZEUTHEN and MARTIN LARSEN, all subjects of the King of Denmark, trading as Silkeborg Maskinfabrik, Zeuthen & Larsen, of Silkeborg, Denmark, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

This invention relates to heat exchange apparatus for liquids, of the type comprising a series of plates disposed face to face and spaced a short distance apart by packing members (which may be incorporated with the plates, e.g. affixed thereto as in the embodiments of the invention hereinafter described) interposed between the plates in alternation therewith, so as to form with the plates passages (usually of relatively small dimension in a direction perpendicular to the plates) for the flow of two fluids, one of which is the heat-supplying fluid and the other the heat-receiving fluid, along respectively the two passages on either side respectively of any given plate of the series having passages as referred to on either side of it.

Heretofore in such an apparatus the passages have usually been of uniform cross-sectional area, or mean cross-sectional area, from end to end of the passage, irrespective of whether the passage has been of unidirectional form or of serpentine or like non-unidirectional form.

The pasteurisation of milk is dependent upon two factors, namely the time occupied by the milk in passing through the pasteurising compartment of the apparatus and the pasteurising temperature of the milk.

In recent years it has to an increasing extent become the practice in the pasteurisation of milk to use a higher temperature and a correspondingly shorter period of pasteurisation, inasmuch as the shorter period and the higher temperature generally ensure a more effective pasteurisation without impairing the quality and taste of the milk.

With the employment for the pasteurisation operation of a heat exchange apparatus of the above-mentioned type, with constant cross-section of the passages, it has, however, proved difficult to apply as high temperatures and as short periods of treatment as might actually be desirable, inasmuch as the milk has been unable to pass over the area available for heating at such a rate and under such conditions as to make it possible to attain the desired increased efficiency without overheating of the milk.

The present invention, insofar as it concerns an apparatus for use in the pasteurisation of milk, aims at remedying these defects by the use in an apparatus of the type described of plates which are so designed that a greater rate of speed may be imparted to the milk as the temperature thereof increases, the arrangement being such that the milk will attain its maximum rate of flow at the moment it attains the required higher temperature, namely the pasteurising temperature.

Since with the use of such plates the transmission of heat through the plates (which will usually be made of metal) will increase as the rate of flow of the liquid increases, the result will be that the liquid will be supplied with the required amount of heat considerably more quickly than has hitherto been possible, while the risk of scorching of the liquid will be reduced. In the result the apparatus will be considerably more efficient than the hitherto known forms of apparatus of the same general type.

According to the invention, a heat exchange apparatus of the type described is characterised in that the cross-sectional area of the passage or passages for the heat-receiving liquid progressively decreases from a maximum at the inflow end of the passage or each passage to a minimum at the outflow end thereof.

Further according to the invention, the arrangement may be one in which, in the case of at least one of the plates, the passage for the heat-receiving liquid extends, from the inflow end of the passage, first in one direction, on one side of a partition-like packing member bounding the passage along one side thereof, and then, after passing round the

end of the packing member, which terminates short of the wall of the passage towards which it extends, in the reverse direction, on the other side of said packing member.

Further, according to the invention, the said arrangement may further be one in which, in the case of at least one of the plates, the inflow and outflow ends of the passage for the heat-receiving liquid are both at the same end of the plate and there are two separate passages for the heat-supplying liquid on the opposite side of the plate, disposed respectively opposite the two portions of the passage for the heat-receiving liquid which are situated respectively on either side of the partition-like packing member, each of said separate passages having an inlet at one end thereof and an outlet at the opposite end and being supplied with its own stream of heat-supplying liquid, thereby providing a construction with which it is possible to arrange that the heat-supplying liquid shall flow in the opposite direction to the liquid to be heated, along the whole course of the passage for the latter liquid.

The invention includes not only the complete apparatus, but also a plate therefor, incorporating the packing member or members which defines or define the passage for the heat-receiving fluid, and similarly a plate for the apparatus incorporating the packing member or members which defines or define the passage or passages for the heat-supplying fluid.

The special tapering form of the passage or passages in a heat exchange apparatus in accordance with this invention also serves to make it possible to attain a smaller counter-pressure against the liquid, inasmuch as due to the greater efficiency of the heating surface the liquid need in many cases, e.g. in the case of milk pasteurisation, pass over one plate only, whereas with a smaller rate of flow along the passage or passages it would be necessary to pass the liquid over two or three plates in succession for the effectual heating of the liquid.

The normal counter-pressure in a pasteurising compartment (using an apparatus of the type described) is about 0.8 atmosphere, whereas when plates with passages according to the invention are used a counter-pressure of about 0.6 atmosphere will generally be sufficient. The reason for this quite material reduction in counter-pressure may be attributed to the fact that along the first part of the passage the rate of flow of the liquid will be almost normal, so that only in the last part of the passage, with the small cross-section, the liquid will have the great rate of flow desired.

The invention is illustrated in the accompanying drawing, in which:

Figure 1 shows a plate of an apparatus according to the invention, with a single passage for the heat-receiving liquid;

Figure 2 shows the adjacent plate of the apparatus, co-operating with the plate of Figure 1 with a single passage for the heating medium;

Figure 3 shows a plate with a reversed-direction passage as above described for the heat-receiving liquid, and

Figure 4 shows a corresponding adjacent plate for the heating medium.

In Figure 1, 1 is a plate, 2 an inlet opening for the liquid to be heated and 3 an outlet opening therefor. The flow passage for the liquid is defined by a packing member 4 affixed to the plate. The heating surface 5 of the plate may if desired be corrugated to impart a pulsating movement to the liquid. Openings 6 and 7 are provided in the plate for the passage therethrough of the heating medium.

In Figure 2, 8 is the actual plate for the heating medium, which is led to the heating surface of the plate through an inlet opening 10 therein. 9 is an outlet opening in the plate for the heating medium. 11 designates the packing member affixed to the plate, said packing member defining the passage for the heating medium, while 12 and 13 are passages extending through the plate for the passage therethrough of the heat-receiving liquid.

In Figure 3 a plate 14 is shown provided with packing members 15, 15a which together define a reversed-direction passage as hereinbefore referred to for the heat-receiving liquid, which is led to the heating surface of the plate through an opening 16 therein, whence it passes first down over the heating surface to the lower end of the packing member 15a, then under said lower end and finally up along the opposite side of the packing member 15a to an outlet opening 17 in the plate. Openings 18, 19, 20 and 21 in the plate are for the passage therethrough of the heating medium. As will appear from the drawing, the cross-section of the passage is largest at the inlet 16 and progressively decreases towards the outlet 17.

In Figure 4 a plate 22 is shown to which packing members 23, 23a are affixed, defining two separate passages for the heating medium. The latter enters these passages through inlet openings 24 and 25 in the plate and leaves by way of outlet openings 26 and 27 therein. The heat-receiving liquid passes through the plate by way of openings 28 and 29 therein.

It will be appreciated, therefore, that in a construction employing the plates of Figures 3 and 4 the heating medium will be supplied at two places in the plate, with the result that it will be possible to deliver fresh heating medium to each of the passages therefor in such a manner that it will flow in the opposite

direction of the liquid to be heated throughout the entire length of the reversed-direction passage therefor.

What we claim is :—

1. A heat exchange apparatus of the type described, characterised in that the cross-sectional area of the passage or passages for the heat-receiving liquid progressively decreases from a maximum at the inflow end of the passage or each passage to a minimum at the outflow end thereof.

2. A heat exchange apparatus as claimed in Claim 1, wherein the arrangement is one in which, in the case of at least one of the plates, the passage for the heat-receiving liquid extends, from the inflow end of the passage, first in one direction, on one side of a partition-like packing member bounding the passage along one side thereof, and then, after passing round the end of the packing member, which terminates short of the wall of the passage towards which it extends, in the reverse direction, on the other side of said packing member.

3. A heat exchange apparatus as claimed in Claim 2, wherein the arrangement is further one in which, in the case of at least one of the plates, the inflow and outflow ends of the passage for the heat-receiving liquid are both at the same end of the plate and there are two separate passages for the heat-supplying liquid on the opposite side of the plate, disposed respectively opposite the two portions of the passage for the heat-receiving liquid which are situated respectively on either side of the partition-like packing member, each of said separate passages having an inlet at one end thereof and an outlet at the opposite end and being supplied with its own stream of heat-supplying liquid, thereby providing a construction with which it is possible to arrange that the heat-supplying liquid shall flow in the opposite direction to the liquid to be heated, along the whole course of the passage for the latter liquid.

4. For use in a heat exchange apparatus as claimed in Claim 1, a component plate therefor for the conveyance of the liquid to be heated, said plate incorporating a packing member or members as hereinbefore referred to and this member or these members defining a flow passage for the liquid which progressively decreases in cross-sectional area from a maximum at the inflow end of the passage to a minimum at the outflow end thereof.

5. A plate as claimed in Claim 4, wherein the passage for the heat-receiving liquid extends, from the inflow end of the passage, first in one direction, on one side of a partition-like packing member bounding the passage along one side thereof and terminating short of the wall of the passage towards which it extends, and then, after passing round the end of the partition-like packing member, in the reverse direction, on the other side of the partition-like packing member, the plate being designed for use in an apparatus as claimed in Claim 2.

6. For use in a heat exchange apparatus as claimed in Claim 3, in conjunction with a plate therefor as claimed in Claim 5, a component plate for the conveyance of the heating medium in which there are two separate passages for said medium disposed respectively in the assembled apparatus opposite the two portions of the passage for the liquid to be heated which are situated respectively on either side of the partition-like packing member of the adjacent plate of Claim 5, each of said passages having an inlet at one end thereof and an outlet at the opposite end, thereby providing a construction with which it is possible to arrange that in the assembled apparatus the heating medium shall flow in the opposite direction to the liquid to be heated, along the whole course of the passage for the latter liquid, the inflow and outflow ends of the passage for the liquid to be heated being both at the same end of said adjacent plate.

7. A heat exchange apparatus of the type described or a component plate therefor, substantially as hereinbefore described with reference to the accompanying drawings.

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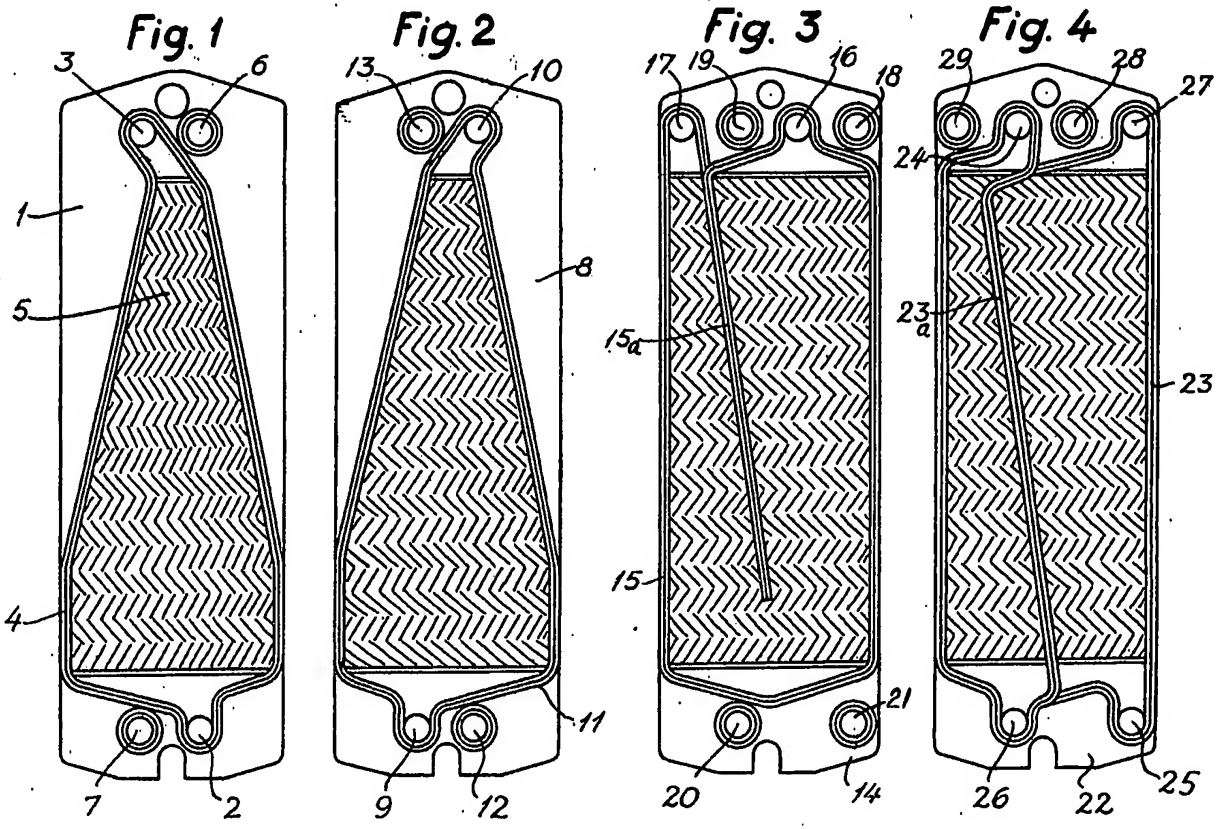

H.M.S.O. (M.F.P.)